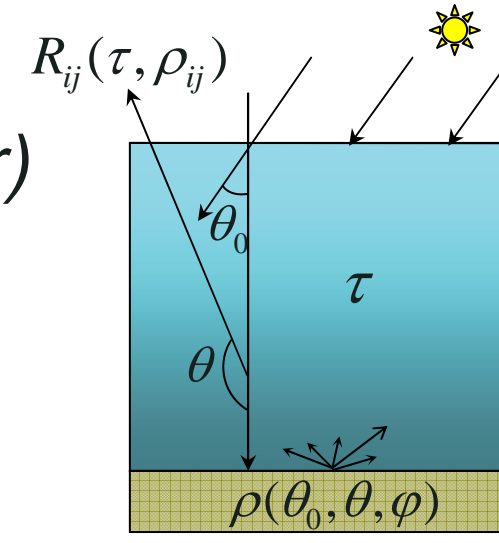# MAIAC - MultiAngle Implementation of Atmospheric Correction for MODIS

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1. Current Status (MODIS …)

- *Dark target method* (Kaufman, Remer)
- Atmospheric Correction (Vermote)

… *use assumptions about surface:*

$$\rho_{ij}^{\lambda} = b^{\lambda}\rho_{ij}^{2.1}, \quad b=0.25(Blue),\ 0.5(Red) \quad - C4$$
$$b \propto f(\lambda, NDVI, \gamma), \quad - C5$$

Consequences for land analysis:

- the temporal and spatial variability in the Blue and Red bands comes from B7 (2.1 μm), and their spectral relationship is fixed by the regression.
- no aerosol corrections over bright surfaces.

2. MAIAC Generic Concept

Goal:
- simultaneous retrieval of AOT and surface BRF

Basis:
- surface is spatially variable and stable in short time intervals;
- aerosols are variable in time and have a meso-scale (60-100 km) range of global variability.

Approach:
- Accumulate MODIS L1B data for K days;
- Grid data;
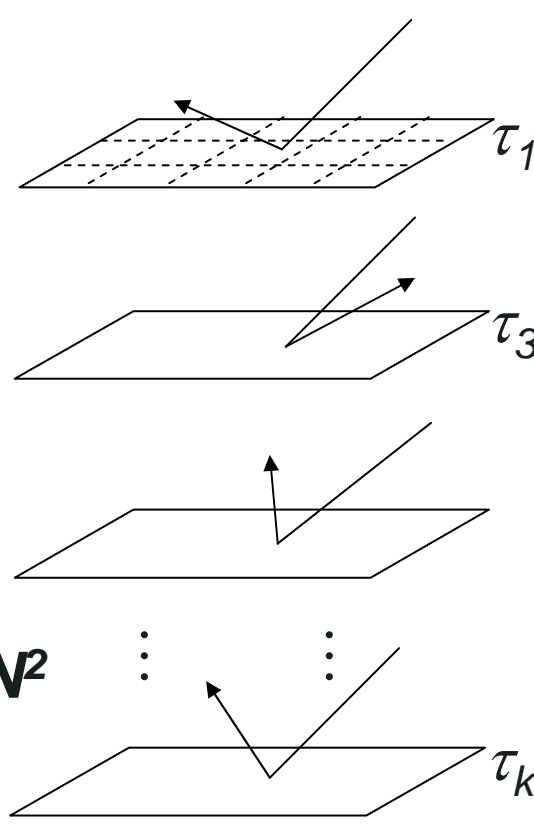- Process K days for N² pixels simultaneously:

  KN^2 (measurements) $> K + (3N)^2$ (unknowns),

  $\Rightarrow$ can be resolved if K>3

  $\{\rho_{ij}^{\lambda} \propto (k_L, k_{go}, k_v)_{ij}^{\lambda} \propto b_{ij}^{\lambda}\}$

- Derive shape of BRF from 2.1 μm, and use spectral scaling for the Blue band:

  $$\rho_{ij}^{B3} = b_{ij}^{B3}\rho_{ij}^{B7} \quad \Rightarrow \quad KN^2 > K + N^2$$
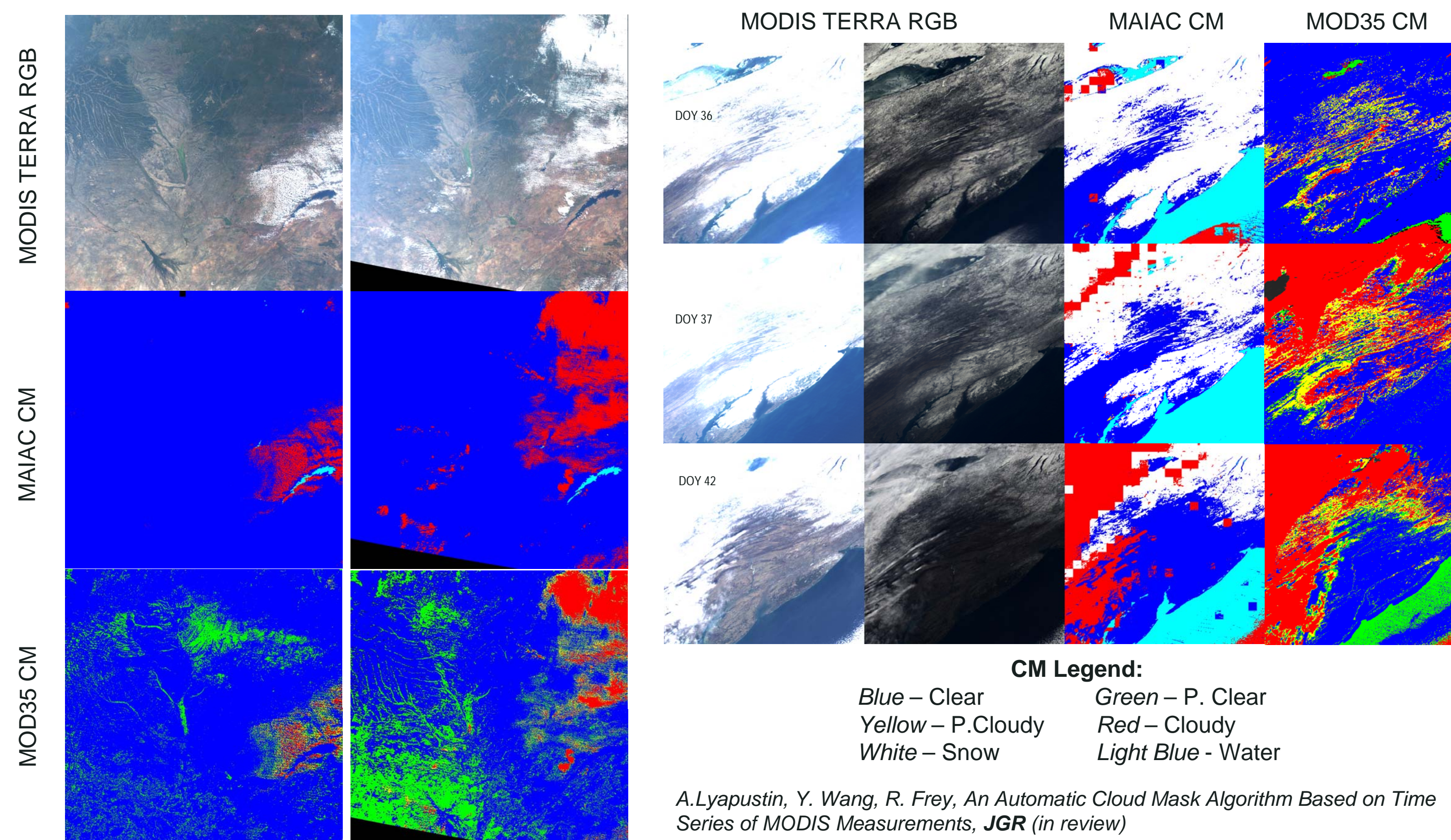
Queue of K days

3. MAIAC Cloud Mask (Cov-based)

Zambia, DOY 130 and 141, Dry Season, 2005

North-East USA, Winter. 2005

MODIS TERRA RGB   MAIAC CM   MOD35 CM

DOY 36
DOY 37
DOY 42

CM Legend:
Blue – Clear   Green – P. Clear
Yellow – P.Cloudy   Red – Cloudy
White – Snow   Light Blue - Water

A.Lyapustin, Y. Wang, R. Frey, An Automatic Cloud Mask Algorithm Based on Time Series of MODIS Measurements, *JGR* (in review)

4. AERONET Validation

At our request, initially the Goddard DAAC and presently MODAPS are producing the subsets of MODIS L1B data for small areas (50 km) for about 160 AERONET sites globally, which are used to prototype MAIAC. Comparing retrievals of water vapor and AOT with available AERONET data provides the means of validating the accuracy and robustness of our retrievals. The examples of validation given below use the MODIS TERRA subsets for 2003.
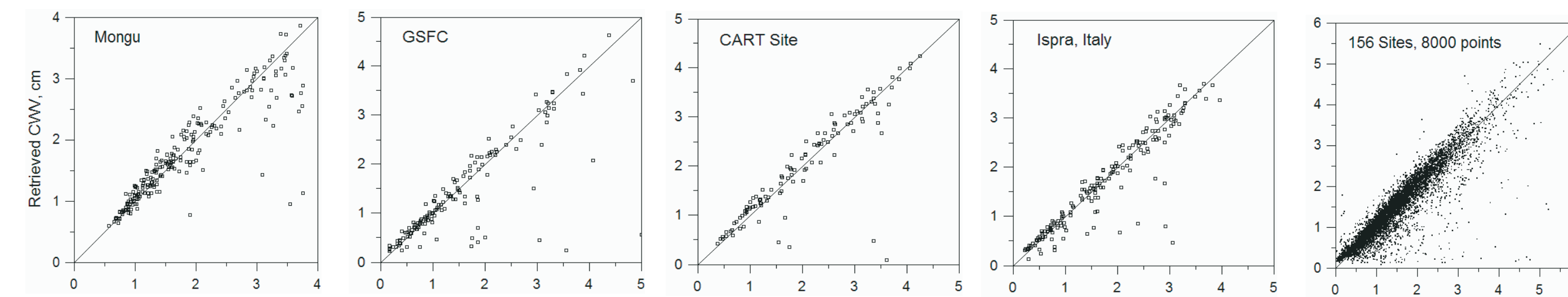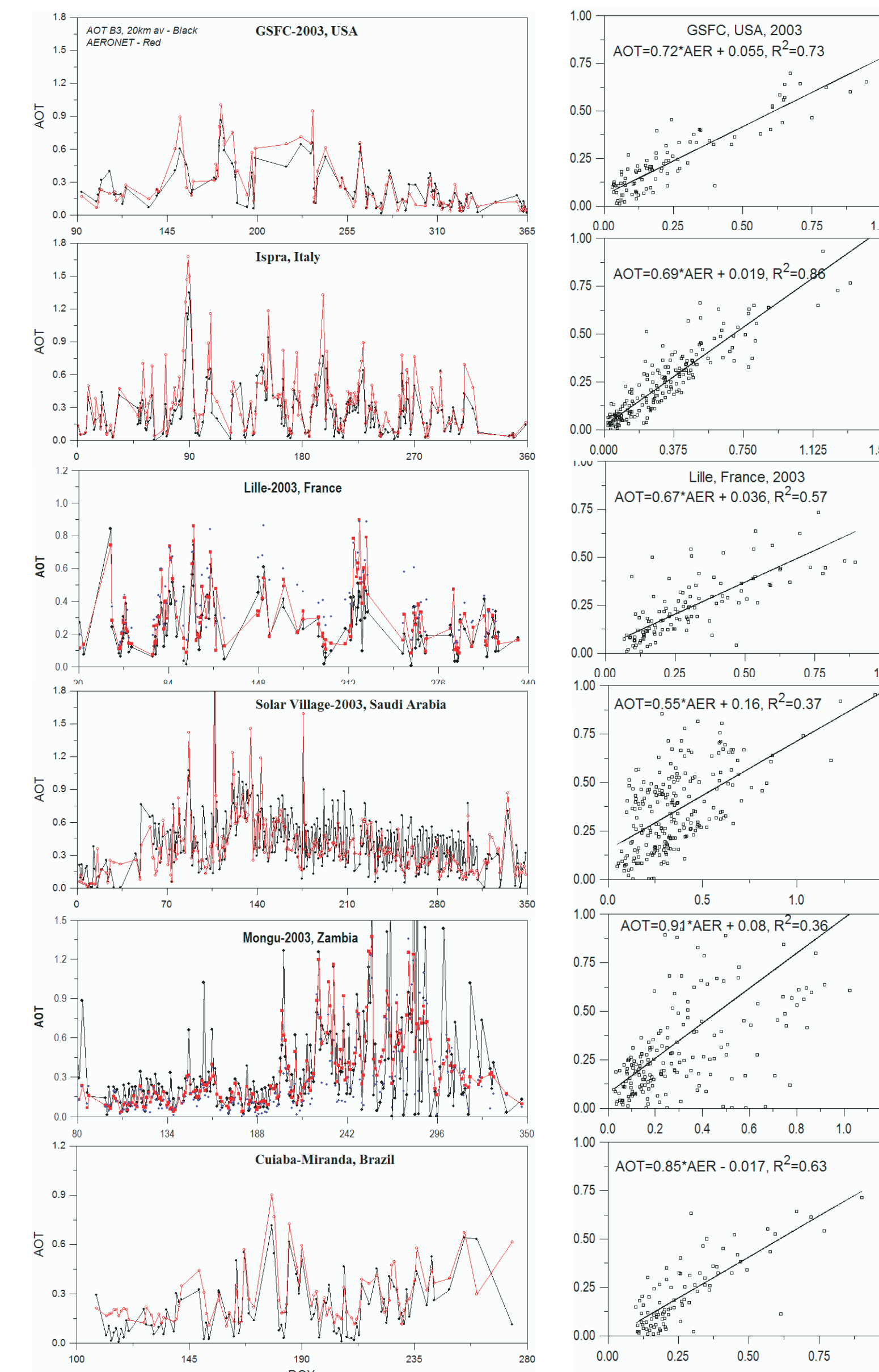
Mongu   GSFC   CART Site   Ispra, Italy   156 Sites, 8000 points

Figure 2. Comparison of retrieved column water vapor with AERONET water vapor data.

Figure 3. Comparison of retrieved AOT for the Blue band with AERONET data within ±30 min of TERRA overpass. The retrieved data are averaged over 20 km area.

GSFC-2003, USA
AOT=0.72*AER + 0.055, R²=0.73

Ispra, Italy
AOT=0.69*AER + 0.019, R²=0.96

Lille-2003, France
AOT=0.67*AER + 0.036, R²=0.57

Solar Village-2003, Saudi Arabia
AOT=0.55*AER + 0.16, R²=0.37

Mongu-2003, Zambia
AOT=0.91*AER + 0.08, R²=0.36

Cuiaba-Miranda, Brazil
AOT=0.85*AER - 0.017, R²=0.63

5. Examples of Large-Scale Processing

Fires: Zambia, day 205, 2005, (1200 km)². 1 km resolution of AOT allows tracing smoke plumes

MODIS TERRA RGB   MAIAC AOT, 0.47 μm MOD04_C4

0.0 0.2 0.4 0.6 0.8

Arabian Peninsula, Day 207, 2005 (1800×1800 km)².

MAIAC AOT, 0.47 μm

NBRF (nadir, SZA=45º). Day 180, 2005.

0.0 0.4 0.9 1.3 1.8

Zambia, Dry (Biomass Burning) Season, 2005, (1200 km)². Interactions between atmospheric moisture, aerosols and clouds.

206   207   224   226   230
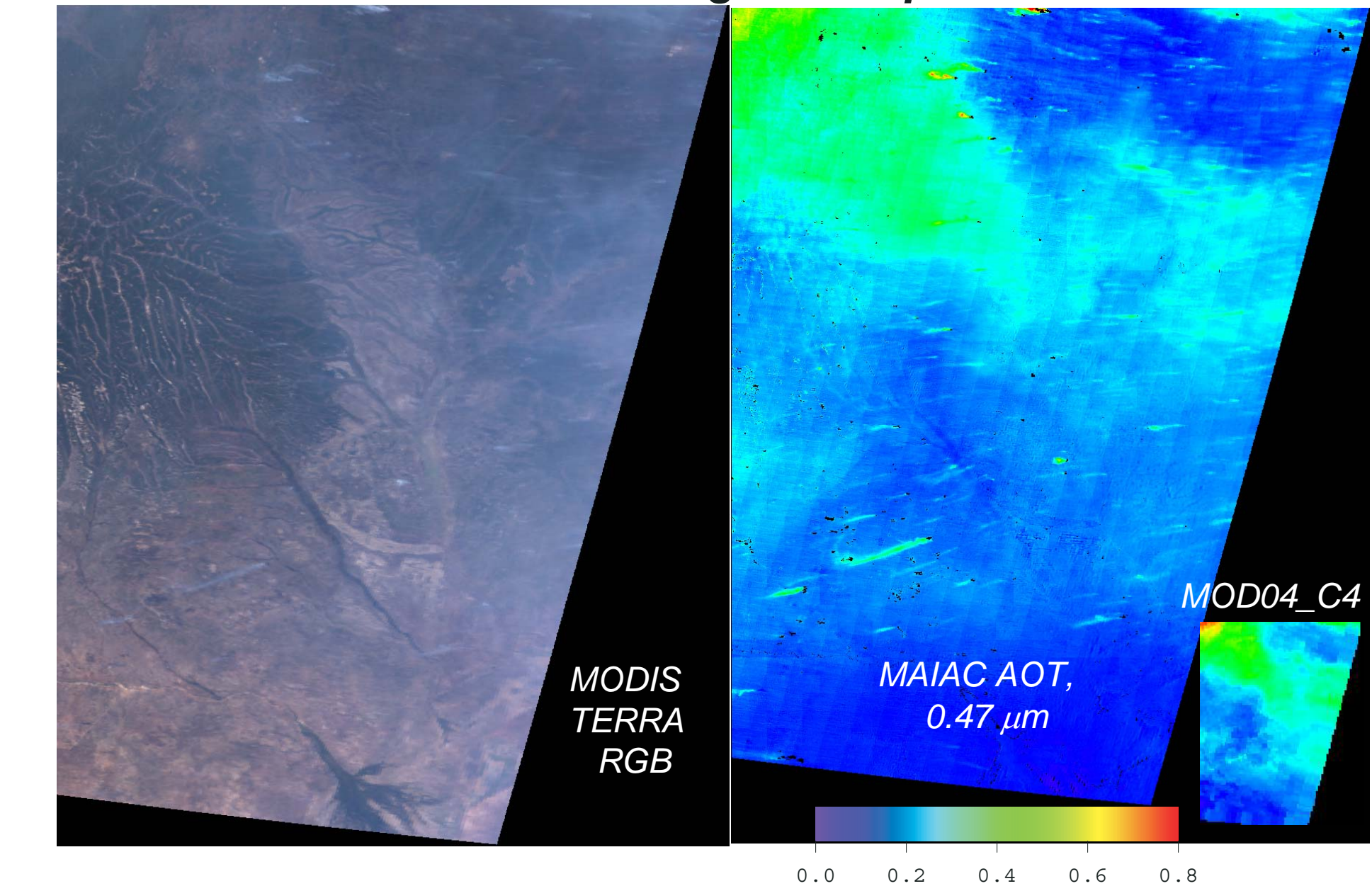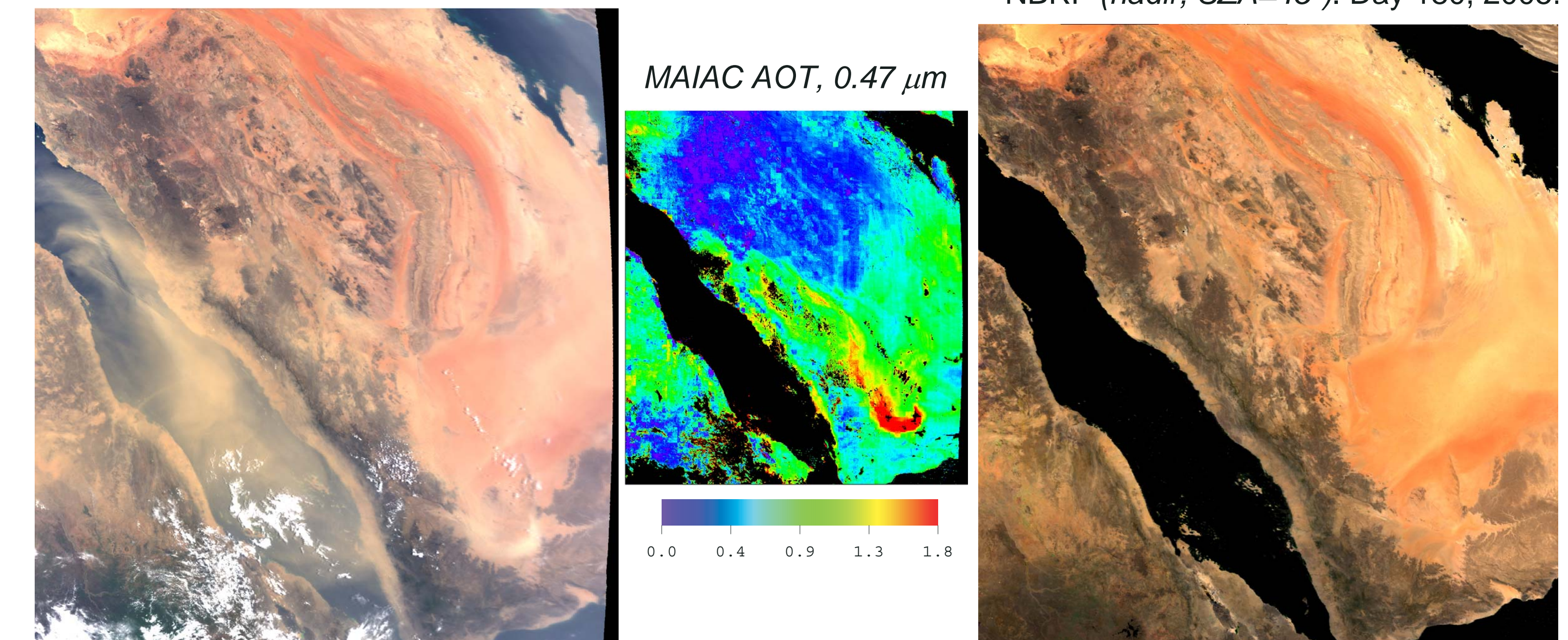
MODIS TERRA RGB

6. SUMMARY

- MAIAC is generic and works globally over all surface types with temporary exception of snow.

- Internal control of consistency of the time series of SR reduces noise and improves quality of results.

- New Cloud Mask Algorithm based on covariance analysis. Better performance, especially in difficult conditions.

- Product Suit: CM, WV, AOT at 0.47 μm and Angstrom parameter, spectral BRF and albedo for MODIS land bands 1-7, and ocean non-saturated bands 8-14L.

- Resolution: 1 km, in gridded format.

ATBD and "movies" of the NBRF time series can be found at:
http://neptune.gsfc.nasa.gov/bsb/subpages/index.php?section=Projects&content=SHARM, section MAIAC ATBD